

# Making of a Tesla Coil

Theory, Formula & Diagram of a Spark Gap Tesla Coil (SGTC)

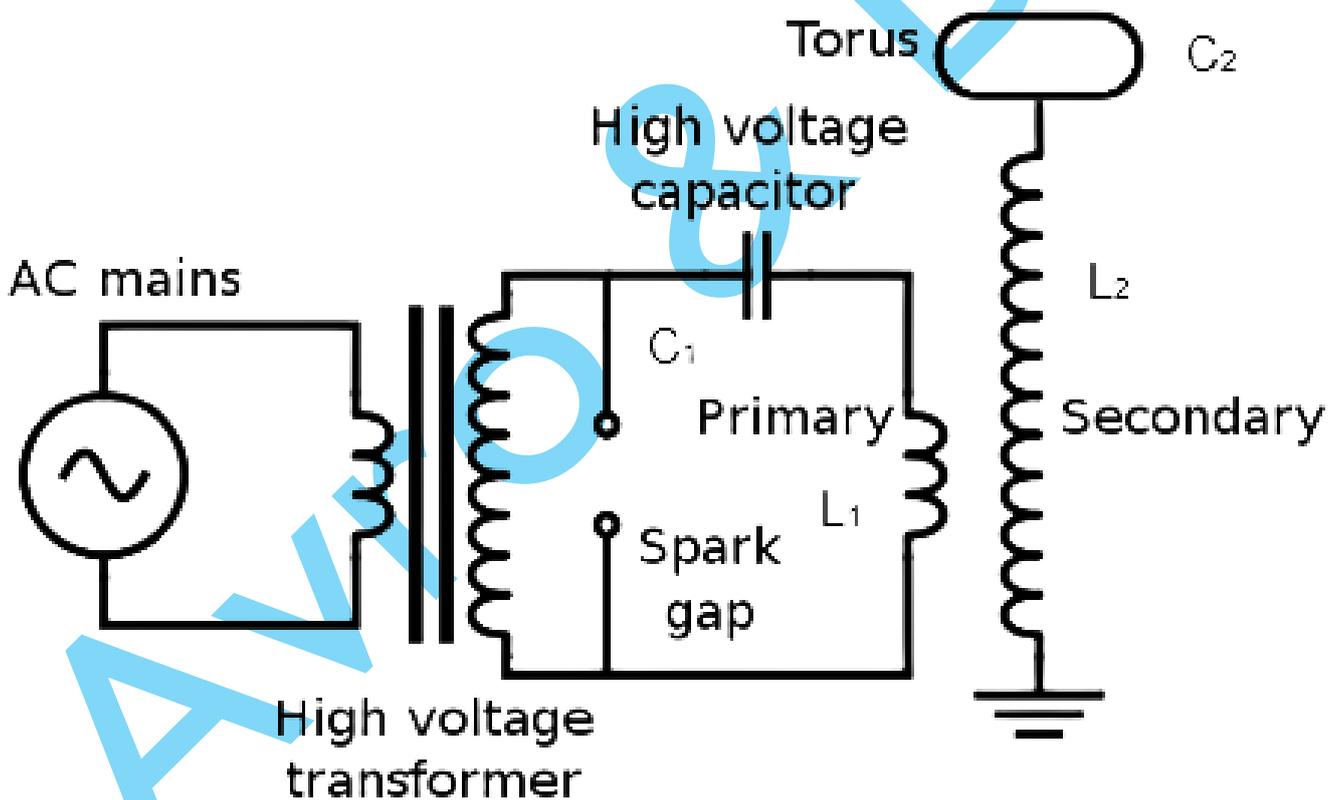
## Introduction:

A **Tesla Coil** is an electrical device invented by the famous scientist **Nikola Tesla** in 1891. It is designed to produce **very high voltage, low current, and high-frequency alternating current electricity**.

A Tesla coil works on the principle of **electrical resonance**, where two coupled resonant circuits transfer energy efficiently from the primary coil to the secondary coil.

This phenomenon allows the device to generate **high-voltage electrical discharges (sparks)** and visible arcs in the air.

Tesla coils are widely used in demonstrations of **wireless power transmission, radio technology experiments, and educational physics experiments**.



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## Formulas & Theoretical Concepts:

Tesla coils operate based on the principle of **Resonance** in electrical circuits. Two resonant circuits (primary and secondary) exchange energy efficiently when their resonant frequencies match.

### Resonant Frequency Formula:

The resonant frequency of an LC circuit is given by:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Where:

- $f$  = resonant frequency (Hz)
- $L$  = inductance (Henry)
- $C$  = capacitance (Farad)

**Note:** This formula is used to tune the **primary & secondary circuits** so they oscillate at the same frequency.

### Inductance of a Coil (General Formula):

Inductance depends on:

- Number of turns
- Coil radius
- Coil length

A simplified expression for a solenoid is:

$$L = \frac{\mu_0 N^2 A}{l}$$

Where:

- $L$  = inductance
- $\mu_0$  = permeability of free space
- $N$  = number of turns
- $A$  = cross-sectional area
- $l$  = length of the coil

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## Energy Stored in a Capacitor:

$$E = \frac{1}{2} CV^2$$

Where:

- $E$  = energy (Joules)
- $C$  = capacitance
- $V$  = voltage

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## General Circuit Concept

A typical spark-gap Tesla coil consists of:

- Power supply
- Capacitor bank
- Spark gap switch
- Primary coil
- Secondary coil
- Top load (metal sphere or toroid)

These components form a resonant transformer system.

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## Safety Precautions ⚠

Tesla coils generate extremely high voltage and must be handled carefully.

1. Never touch the coil while it is operating.
2. Keep electronic devices away from the coil.
3. Operate only in a dry and open area.
4. Use proper grounding for the system.
5. Keep flammable materials away from sparks.
6. Always turn off power before adjusting any component & ensure all capacitors are fully discharged before touching the circuit.

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## Operating Instructions

1. Place the Tesla coil on an insulated surface.
2. Ensure all electrical connections are secure.
3. Connect the power supply to the circuit.
4. Switch on the power source carefully.
5. Observe the high-voltage discharge from the top electrode.
6. Turn off the power after demonstration.

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## Requirements:

### 1. The Structure & Coils (The Tower)

- **The Tower Pipe:** One piece of 1.5-inch diameter PVC pipe, cut to 1 foot (30 cm) long.
- **The Secondary Wire:** 100 grams of 34 SWG (32 AWG) Enamelled Copper Magnet Wire. (Must be one continuous spool, no joints!)
- **The Primary Wire:** 3 meters of 1.5 sq. mm (or 14 AWG) thick, insulated solid-core house wire.
- **The Top Load:** A smooth plastic or Styrofoam ball, plus a roll of smooth aluminium foil to wrap it in (or just an empty, polished Red Bull can).
- **The Breakout Point:** 1 metal sewing needle or a sharp piece of stiff wire to tape to the top load.

### 2. The High Voltage Engine (The Power)

- **The Driver Board:** 1x ZVS Induction Heating Power Supply Module.
- **The High Voltage Coil:** 1x Salvaged CRT TV Flyback Transformer (Get this from an old local TV repair shop).
- **The AC/DC Converter (Rectifier):** 1x KBPC3510 Bridge Rectifier block (or four heavy-duty 6A10 diodes).
- **The Smoothing Capacitor:** 1x 4700uF or 6800uF Electrolytic Capacitor. **Crucial:** It must be rated for at least 50V.
- (Note: You already have the 250V to 12-0-12 AC Transformer, so that is checked off!)

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## 3. The Resonant Circuit (Capacitor Bank & Spark Gap)

- **The MMC Capacitors:** 15 pieces of 0.33uF 1200V MKP Induction Cooker Capacitors.
- **The Spark Gap Electrodes:** 2 thick brass screws or two small brass L-brackets. (Brass handles the plasma heat much better than standard steel).

## 4. The Base & Mounting Hardware (The Chassis)

- **The Base Board:** A 1 ft x 1.5 ft sheet of thick Black Acrylic or dry MDF wood. (A black acrylic base will give the whole build a massive, premium cyberpunk/hacker vibe).
- **The Tuning Clip:** 1x Alligator clip. You will solder this to one end of your primary circuit so you can easily clip it onto different turns of your flat copper spiral to tune the resonance.
- **Mounting Gear:** A handful of small wood/acrylic screws, some zip-ties to strap down the heavy capacitors and flyback, and maybe some hot glue.

## Component Images:



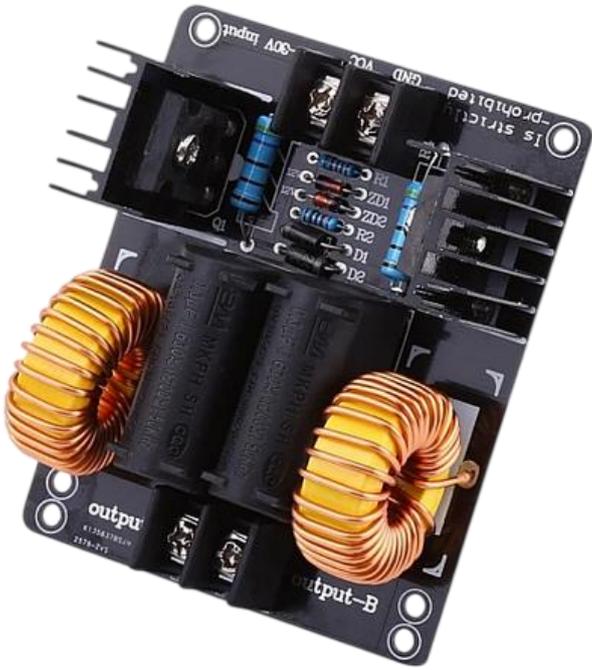
14 AWG Copper Wire  
3 Meter



34 AWG Copper Wire  
150 Meter

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**ZVS Tesla Coil  
Power Supply**

**0.33 $\mu$ F 1200V MKP  
Induction Cooker  
Capacitors**



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**4700uF Rated  
Electrolytic Capacitor**

**Salvaged CRT TV  
Flyback Transformer**

